METHODS IN ANIMAL PSYCHOLOGY.

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The differentiation of comparative psychology, as a branch and method to general psychology, has been comparatively slow. Its growth, however, has been natural and healthy, and its contributions to the study of mind are ever increasing in value. A complete historical account of this differentiation would be quite premature; yet it may be worth while to note in passing that several of the special problems of psychology,—for example: emotions, instinct, habit, heredity, etc., have been treated on very broad lines by such all-around scientists as La Marck, Brehm, Darwin, Kingsley, Wallace and Agassiz. A little later, men like Naegal, Huxley, Romaines, Lubbock, Graber, and Spalding, began to focus down and make experiments and observations on the senses, habits and intelligence of animals. Running somewhat parallel with these two groups of more purely scientific writers are the speculative and philosophic pens of Oken, Lewes, Spencer, Schneider, Weismann, Büchner, Cope and others who have evaluated and ennobled the facts of organic life by indicating their significance on the more serious and time-honored problems of mind and philosophy.

At present, definite problems, as the formation of association processess,[1] imitation, habit and instinct, are put to animals by playing upon some one or more fundamental instincts and taxic motions like those of hunger, sex, discomfort in solitude and prison, preferences for certain colors, geotaxis, chemotaxis, tonotaxis, etc. The ablest representative for psychology in this work is Lloyd Morgan, whose careful and critical interpretations of the objective manifestations of mind through bodily activities have done much to make comparative psychology reputable as a science, and even now essential to a comprehensive understanding of the more fundamental problems of mind. Wundt likewise has criticised to great advantage the usual erroneous and loose interpretations of animal activities. Criticisms of this type should not cease yet awhile.

The matter of interpretation at this stage, however, it seems to me is secondary. The most urgent need at present is more and better methods to get at the facts, which, when once discovered, will receive ample and proper attention.

[1] Thorndike, Edward L.: Animal Intelligence. An experimental study of the associative processes in animals. N. Y., June, 1898.

The systematic study of animals thus far has been conducted along two lines: oue, for a better name, we shall call the *natural method.* This consists in observing carefully and continuously the free life of an animal, for example: Huber, Moggridge, and McCook on ants, Audubon on birds, Figuier on insects, Mills[1] on our domestic animals; the second line of work may be termed the *experimental method.* Here the animal is subjected to certain conditions essential in putting a question, and that favor the performance of activities that shall contribute material for answering a problem.

Both methods are necessary to a more abundant ingathering of facts. Both are frequently used by the same investigators, *e. g.*, Lubbock and Bethe[2] on ants, and Morgan on birds. Both have their share of errors and abuses. In the natural methods the cleverness of animals is sometimes overestimated, anecdotes of a questionable foundation are given too much credence. In the experimental method, conditions too artificial are liable to be created, thereby inhibiting the free expression of the animal's acts. Fear is too often present, dominating and modifying every act. A recent investigation makes exclusive use of the second method, which seems to me exposes the results to serious criticism. I shall revert to this investigation later in this paper.

Partly as an illustration of the use of these two methods combined, partly to reinforce observations already made, and lastly to present a bit of new material, I present the results of experiments and observations made on vorticella, wasps, chicks and rats.

VORTICELLA GRACILIS.[3]

The object here was to discover what activities, if any, have a psychological significance or value. The activities may be subsumbed under the following rubrics: Self-preservation, reproduction, and "miscellaneous." The first includes all those movements, whatever, both of the whole and parts of the cell, exerted in food-getting, ejecting detritus, placing the mouth in a more advantageous position for receiving food, contracting the stalk to escape an enemy, or when cilia touch any large body, dead or alive, etc.

The reproductive activities need no specification. Miscellaneous activities include all those movements for which we can

[1] Mills, Wesley: Animal Intelligence. 307 pp. The Macmillan Co., 1898.

[2] Bethe, Albrecht: Dür fur wirden Ameisen und Biemen psychische Qualit äten zuschreiben? Pflüger Archiv für Physiologie. Bd. LXX 1898.

[3] I am greatly indebted to Dr. C. F. Hodge for many valuable suggestions in carrying out this experiment.

assign no cause, *e. g.*, violent contraction of the stalk at a time when the field is free from any disturbing element that might be revealed by the microscope, food abundant, and body fairly well filled. Probably a study directed with a view to ascertain its chemotaxic and tonotaxic reactions would make some of these activities meaningful. I turn to the activities of self-preservation and note first the movements of the body as a whole. If the long axis of stalk and calyx is in and with a current of water,[1] the calyx is soon turned across the stream, forming an angle with the stalk. It is evident, owing to the well-known bell-shape of the calyx and the position of the cilia, that thus turning the bell would greatly facilitate food getting. Is there a psychical element in such a movement, *i. e.*, is the movement the outcome of the exercise of a psychical force? It appears to me that an affirmative answer is open to two serious objections: *First*, it can be explained in several other equally as plausible terms. The reaction to hunger alone is sufficient to account for the movement, and when we reflect that the habitat of V. is on grasses bathed by currents, natural selection might well be invoked as the principle that has impressed a reflex or mechanical movement of this sort on the cell. Then again, the inequality of the density of the current on the sides of the bell is a stimulus sufficient to cause a reaction expressed in movement (*tonotaxis*). Reactions of this sort occur in paramœcia,[2] hydra,[3] frog, and the human conjunctive; *second*, to ascribe a directing role to whatever psychoses that may be present in these forms to activities of this sort, precludes further investigation—just as the "fiat creation hypothesis" of the middle ages kept men from enquiring into the more rational ways of world growth.

The mouth cilia are so directed as to either receive or reject small particles of matter. These activities have been championed as psychical. That the cilia do these things there can be no question, but that they are movements directed by a psychosis, *i. e.*, are really selective, expressing choice, is quite another question. Before this question can be scientifically discussed, it seems to me another question must first be determined, viz.: Have vorticellæ a choice in food—do they not

[1] A current of sterilized water carrying yeast cells from a large flask was kept flowing under the cover slip. The water was drawn from the flask through a glass syphon, down to a capillary point, placed at one end of the cover slip, and a filter-paper drip attached to the other end. The microscope used was a Zeiss, apochromatic series, comp' ocular 12 objective 16 mm., which gave a magnification 190 diameters, and sometimes ocular 6, objective 4 mm. was used—magnification 375 diameters. The vorticellæ were found in great abundance from flags placed in an aquarium three weeks.

[2] Jennings, H. S.: Reaction of Ciliate Infusoria. *Journal of Physiology*, Vol. 21, 1897, pp. 258–321.

receive both digestible and indigestible material alike, and when filled eject both alike? It is a physical impossibility to receive even all the digestible material that comes their way. If given yeast they will receive 2, 3, or 4 grains at once and will then whirl the others away for 5, 10, sometimes 15 minutes before admitting any more. So that what has been interpreted as a selective process may be a reaction to "enough." To get facts that would answer the question one would have to first find a material[1] that they reject[2] altogether, then mix it with a palatable food, say yeast grains, and note their reactions toward the mixture.

I present in Table I the notes from my diary on a typical experiment with vorticella. It presents nothing essentially new or different from the work of Drs. Hodge and Aiken, save that yeast is a food for all the V. that I observed.

Again, do they discern between enemies and friends, between what is harmful and unharmful? If they do, we should expect to see the stalk contract in the presence of certain objects and remain extended in others or even remain in contact with them; and if they do not, we should expect the stalk to contract when the calyx comes in contact with any rigid, resisting, unmanageable object, organic or inorganic, dead or living matter. The latter condition is just what we do find. Vorticella takes no risks, trusts nothing, as it were, but contracts the stalk whenever the sensitive parts of the calyx or cilia meet with any resisting body whatsoever. I have observed the stalk contract when yeast cells and other food material came floating by in unmanageable quantities, or when the peristomal region came in contact with a large colony of bacteria—if the colony is small, they are hurled away by the cilia. I counted 118 stalk contractions due to the calyx hitting a dead leaf fibre. How long it had been reacting to this particular object, and how much longer it would have continued, had no accident intervened, can only be conjectured.

It seems to me all that we can say here is that the sense of touch mediates bigness, and persistence or rigidity, and reactions to such stimuli imply nothing more than simple mechanical reflexes.

Under the category of reproductive activities it is sometimes urged that the attachment of the free-swimming zoid near the base of the calyx is an expression of choice of selection on the part of the zoid, and therefore psychic. The zoospores of the cryptogamic world do equally as clever things in selecting

[1] This problem was suggested to me by Dr. Adolf Meyer.

[2] The substance would have to be partly insoluble, at least in water, and of low specific gravity. I suggest pepsin, lycopodium powder, a few of the salts of calcium and barium, ground glass and the like.

the right oospore in which to penetrate. My fondness for mysticism and the "brand-new" is too feeble to urge me to invade the botanist's realm searching for psychological material.

The presence of a psychoses is not denied. There may be feelings corresponding to the stimuli bigness, rigidity or persistence, whenever the organism mechanically responds to such. All that I affirm is that these activities give no indication that they are the outcome of the exercise of a psychical principle.

Table containing the observations on Vorticella gracilis.

EXPERIMENT 12.

Date and time.	Contraction of Stalk.	Remarks.
Nov. 22, 7.00 A. M.	None.	Cilia moving slowly. Vesicle closing about 3 per min.
" 7.45 "	None. Stalk well extended.	Feeding occasionally. Takes in yeast grains.
" 8.05 "	Regularly.	Stopped feeding.
" 8.45 "	Feeble.	A swift current bearing yeast grains has just started up. The long axis of stalk and bell are in line with current.
" 9.00 "	4 x per min.	
" 9.15 "	Less frequent.	Feeding again. Taken in two yeast grs.
" 9.25 "	None.	Takes in yeast grs. occasionally, permits the great majority to go by after being twirled rapidly by the cilia. It is a physical impossibility to take in all the yeast grains that come by, or, for that matter, other food material. The food revolves around a common center. The diameter of each revolution of any one revolving food mass grows shorter. The food thus approaches the center, but not quite, as it gradually works toward the mouth when nearing complete digestion.
" 9.45 "	Once, when a large torulae struck the body near the mouth parts.	Feeding slowly. Takes in 3 or 4 yeast grs. at once, then sets them to revolving with the great mass of food.
" 9.55 "	None.	Has turned the bell almost at right angles to the stream, (the stalk is in line with the stream). This offers a better position for taking food.
" 10.00 "	None.	Two yeast grains, after making one revolution, were hurled out not seriuosly injured.
" 10.10 "	None.	Ejected yeast detritus, *i. e.*, cells that had been digested to a shapeless mass.
" 10.30 "	None.	Followed two yeast grains through one revolution; time, 4 min. and 45 sec., about.

Table containing the observations of Vorticella gracilis.
(Continued.)

Date and time.	Contraction of Stalk.	Remarks.
Nov. 22, 10.35 "	None.	A torulae of six grains rest on the base of the bell. V. does not move—indifferent to their touch. Heretofore, when a similar bunch was caught about cilia and lip, contraction of stalk followed at once.
" 10.45 "	Once, violent.	Threw off the chain of torulae at base. It had supported the chain 15 min.
" 10.55 "	None.	Revolution of food not regular. Sometimes it moves by jerks.
" 11.03 "	None.	The body has been distended with yeast grs. for one hour.
" 11.30 "	None.	Yeast cells in all degrees of digestion.
" 11.55 A.M.	None.	Body growing shorter and thicker.
" 12 M.	Regularly.	Body has two mouths—a clearage line can be made out. At one edge of the field V. No. 2, that has likewise been under observation from the beginning, is also dividing. Differed from V. No. 1 only in feeding; has eaten less yeast, digested all.
" 12.15 P.M.	Rapid and violent.	Division complete with No. 2, making two bells attached to the same stalk.
" 12.20 "	Irregular but strong.	At close of clearage No. 2 daughters were roundish, dumpy, now becoming more bell shaped.
" 12.45 "	None.	No. 1 has completed divison. Neither No. 1 nor No. 2 have taken food for 45 min.
" 12.55 "	None.	No. 2 has begun to feed—taken in three yeast grains.
" 1.15 "	No. 2 violent and rapid.	No. 2 has lost her daughter. No. 1 eating yeast grains again.
" 2.00 "	Feeble.	No. 1 daughter bell detached. No. 1 throwing out digested material. Current has slowed up, yeast grains scarce.
" 2.15 "	Occasionally.	Cilia are developing about the base. Has stopped feeding, ejected most of detritus. Mouth cilia moving slowly and body elongating.
" 2.16 "	None.	Body rotating around stalk and quivering with violent action. Current nil.
" 2.18 "	Twice, violent.	Broken off from stalk and swimming away, having been under observation 7 hrs., 18 min.
" 2.30 "	None.	Current in region of No. 2 has run continuously.
" 2.40 "	None.	Feeding on yeast and other material that has somehow fallen into the current.
" 3.00 "	Occasionally.	Stuffed with yeast, body bent obliquely to the stream.

Table containing the observations of Vorticella gracilis.
(Concluded.)

Date and time.	Contraction of Stalk.	Remarks.
Nov.		
22, 3.15 "	None.	Yeast grains revolving—being digested.
" 3.45 "	None.	Ejecting detritus, taking in yeast grs. and other foods.
" 4.00 "	None.	Vesicle contracts about 3 x per min.
" 5.00 "	None.	For the last hour but little feeding, no yeast received, body filled with it.
" 5.10 "	None.	Food massed being churned, moved back and forth through the long axis of bell instead of revolving.
" 5.35 "	Once. Bell struck by a monster.	Filled like a balloon, takes in a yeast gr. occasionally. The great majority are made to pass on.
" 6.05 "	Feeble.	Food mass revolving again.
" 6.30 P.M.	Occasionally.	Body shortening and thickening.
" 6.45 "	Violent.	Second division has begun.
" 7.00 "	4 x per min.	Cleavage line distinct. Two mouths.
" 7.15 "	Few.	Division complete.
23, 7.30 A.M.		No. 2 still in the field—bacteria have developed during night to an alarming degree.
" 8.00 "	Every time cilia twirls bacteria or run into a mass too thick to be twirled.	Body well filled.
" 9.00 "	Violent.	Had stopped feeding for some time. Developed cilia and at 9 A. M. floated away. It had been under observation 26 hrs., 12 hrs. and 15 min. of which were constant.

WASPS. (*Polistes rubiginosus.*)

Sense of Smell.

The apparatus[1] consisted of a board 48 inches long and 15 inches wide, on which was built a glass hallway 18 inches long, 1½ inches wide and 1 inch high. One end of this long hall opened into two halls of similar dimensions, save their lengths, which was 9 inches. These short halls diverged from each other at an angle 70°. Both led into a single box, which was usually kept dark. These short halls I called "forks." The floor and top of the halls were glass. The odor was dropped on cotton batting the size of a pea. Odorous cotton was placed in the fork about 3 inches from the end of the long hall. At the same time the opposite fork contained a bit of odorless cot-

[1] For valuable help and suggestions in the construction of apparatus and experimentation, I desire to thank Mr. Willard S. Small.

ton—the object being to present as far as possible similar conditions to the eye. The apparatus was placed directly in front and about twelve feet from a window. The end containing the dark box was kept toward the window. The wasps used were a large, reddish, yellow-bodied, black-winged social species, *Polistes rubiginosus*, sent me from Virginia. While being introduced into the glass hall at the end away from the light, they were handled by broad and *very pliable* forceps. Gentle handling *must* be observed. At the close of each experiment the halls were thoroughly deodorized. This requires much time. The experiment should be performed on bright days, and in a temperature not below 60 F. The following odors were used: asafœtida, bergamot, carbolic acid, cinnamon, cologne, oil of cologne, cloves, pennyroyal, tar, turpentine, violet, sassafras, alcohol and spearmint. I have copied below three experiments from my notebook, the rest are presented in tabulated form.

ODOR: CARBOLIC ACID. NUMBER OF WASPS USED: FOUR.

Odor on the Right.

Wasp No. 1. Stopped about four inches in front of the forks—rubbed antennæ vigorously with fore leg for about 30 seconds, then took the left hand fork to the dark box.

Wasp No. 1. Stopped about six inches in front of the forks and after much hesitation and turning back and walking nearly the whole length of the hall, he went in on the left side.

Wasp No. 1. Walked straight down left fork without halting.

Wasp No. 2. Stopped about four inches in front of forks, then turned back. Approached again, crawled back and forth from fork to fork; at last crawled up to the top glass of the right fork and crawled into the box back down.

Wasp No. 2. Much excited—mad—crawled right over odorous cotton and went in box via right side.

Wasp No. 2. Approaches forks slowly, much brushing of antennæ; at last takes left fork to box.

Odor on the Left.

Wasp No. 1. Went in via left—crawled over the odorous cotton.

Wasp No. 1. Went in via left, hugged the sides of the wall while passing the odor.

Wasp No. 2. Went via right, after much hesitation at forks.

Wasp No. 2. Went via left, but avoided the odor by hugging the side of the wall.

Wasp No. 3. Went via right fork after halting one minute at the forks.

Wasp No. 3. Went via right; seemed much confused.

Wasp No. 3. Went via left after much hesitation and turning back and forth; hugged the under side of the top glass.

Wasp No. 4. Went via right; seemed pure chance.

Wasp No. 4. Went via right after much waving of antennæ and examining both roads.

Wasp No. 4. Stopped at forks, started down left, recoiled, and crawled back to the far end of the gallery; returns, stops at forks, cleans antennæ, then goes via right fork.

Summary.

Sixteen tests, thirteen of which showed conclusively that the odor was sensed, and eleven that it was objectionable.

Odor: Tar. Number of Wasps Used: Two.

Odor on the Right.

Wasp No. 1. Went via left fork; pure chance.
Wasp No. 1. Went via left; seemed not yet to have sensed it.
Wasp No. 1. Went via right; gave no attention to tar.
Wasp No. 2. Went via right fork; indifferent to tar. Cannot tell whether tar was even sensed.
Wasp No. 2 went in via right fork; came out of dark box into right fork, walked over the odorous cotton; seemed quite indifferent.

Odor: Absolute Alcohol. Number of Wasps Used: Four.

Odor on Right.

Wasp No. 1. Halted four minutes about three inches in front of odor, brushed antennæ vigorously, then crawled up the side of wall of right fork and passed into dark box.
Wasp No. 1. Went via left fork; this time seemed pure chance.
Wasp No. 1. Went via left fork, halted some time about two inches in front of odor, reared back, and finally took left fork to dark box.
Wasp No. 2. Turned down right fork, stopped about 2½ inches before odor, waved and stroked antennæ vigorously, reared back and plunged forward repeatedly, finally crawled in back down, on under side of top glass.
Wasp No. 2. Halted at forks, brushed antennæ, went in via left fork.

Odor on Left.

Wasp No. 3. Went in via left fork; avoided odor by hugging the side walls. Was mad and excited.
Wasp No. 3. Went via right; still mad.
Wasp No. 4. Walks slowly down gallery; stops at forks, waves antennæ and strokes them vigorously; then crawls up to the top glass and starts down the left fork; stops just before getting to odor, turns back and forth in much confusion; finally turned back and went via right fork.
Wasp No. 4. Went via right fork; did not halt anywhere on the road.
Wasp No. 3. Started down left fork, stopped in front of odor for some time, then turned back and forth repeatedly, finally crawled in via left fork, hugging side of the wall.
Wasp No. 3. Went via right, did not stop at forks.
Put 3 and 4 in long gallery together. No. 3 crawled down right side, did not halt at forks, kept straight ahead to dark box via right fork; and No. 4 stopped after entering the left fork, turned back and went via right fork.

Summary for Tar and Alcohol.

Tar may be sensed; it certainly is not objectionable. The twelve tests with alcohol show that it is sensed and that it is decidedly objectionable.

Unobjectionable.	Objectionable.	Doubtful.
Tar	Asafœtida	Cinnamon
Turpentine.	Bergamot	Violet
	Carbolic Acid	Sassafras
	Cologne[1]	
	Oil of Cologne	
	Cloves	
	Pennyroyal	
	Alcohol	
	Spearmint	

Conclusions. (1) wasps readily sense odors; (2) some are much more objectionable than others, *e. g.*, spearmint caused the most violent reactions. They moved up and down the galleries as if frightened or pursued by an enemy; (3) some odors, as tar, turpentine, are not disagreeable; (4) there is much evidence showing that the sense of smell fatigues—more observations, made with the greatest precautions, are needed to make this conclusive.

CHICKS.

I used chicks of two incubations of about five weeks apart. The first group were returned to their rightful parent at about the age of eighteen hours. To the second group I was foster parent fourteen days, and from their standpoint many days longer, for they often ran joyfully to me and followed me when I went among the farm poultry. They knew no other parent. Both groups, which were cross-breeds of Plymouth Rock, Leghorn, and Minorca, were taken from the hen eight to twelve hours before they had pecked through their shells, and kept awhile in warm water and then transferred to an incubator.

Group one, consisting of two little birds. At the age of four hours I placed them on a large newspaper spread on the floor. Their repeated efforts to stand erect invariably resulted in their toppling over sometimes forward, sometimes backward to a complete somersault. The tarso-metatarsus (featherless portion of the leg) does foot duty at this age, so that the distal end of the leg when standing is the tibio-tarsus. Walking is really running, darting forward from 16 to 30 inches and ending in a sprawl. After attempts to stand or walk, they take cat-naps.

These naps occur every few minutes, during which time the neck is stretched at full length on the floor and the head resting on one side. They nap most frequently in direct patches of sunlight. On awaking, clumsy attempts are made to smooth out the matted down—their only feathers—which had been un-

[1] It was thought that the objectionable element in cologne was the alcohol. The oil of cologne contains no alcohol, but they still avoided it, even though a very small drop was used.

kempt from the beginning. Only bright objects or strongly contrasted colored objects are noticed and pecked; large letters on the paper, bright threads in the carpet, at crawling flies, but with no success; bits of white pine, at their own and each other's toes, and at each other's bills, eyes and combs. At times they try to hover or cuddle under each other. I hold my hand over them under which they huddled close together. They act similarly toward almost any object held gently to their backs and heads—a stick of wood, a flannel rag, a shoe, a sock, a tin pan.

Age, six hours. Gave them crumbs of dough and bits of egg shells at which they frequently pecked but very seldom swallowed. They seized fairly well whatever they aimed at, but seemed to have trouble in holding it and getting it adjusted for deglutition. They follow, although their pursuit is interrupted by frequent falls, any comparatively large moving object: a hat, a folded garment, a tin pan, the cat, a person. I walk by one piping the want note, which by the way is their earliest and most frequent note, to a doorway ten feet distant, pass through the doorway over a sill ten inches wide inclined at an angle of fifteen degrees, the lower edge one and one-half inches high, into the next room and step behind the door. The chick makes the door sill in two runs, and to my surprise gets upon and over the inclined door sill and enters the room to a distance of eight or ten feet, looking and piping to the fullest capacity of its voice. Finally it takes a nap.

Age, eight hours. One swallows a dead fly after mangling it. I clap my hands close to their heads, make a loud hissing noise, they take no notice of either noise. I thrum on a guitar; this startles them, but they settle down so soon as the noise ceases and sleep, especially if the thrumming lasts from 30 to 45 seconds. Later they chirp the want note vehemently. I sneeze—they stop chirping for some seconds. Striking a pan has the same effect.

Group two consists of four chicks. Chicks Nos. 1 and 2 born August 28, 4 P. M., No. 3 August 29, 11 A. M., and No. 4 at 3 P. M.

17 hours old. August 29, 9 A. M. Nos. 1 and 2 now 17 hours old are placed in their poultry yard, 4 ft. wide, 5 ft. long and 2 ft. high—built in an attic with southern exposure. I give them cracked wheat, bits of half matured maize. They peck at the larger pieces of food and succeed in getting them into their mouths, but allow them to fall out. At last No. 2, the larger and brighter of the two, after making three trials to swallow a half a grain of wheat succeeds in the fourth attempt. They do not confine their attention long—15 seconds to about 30 seconds—to the different foods, in fact they are more con-

cerned about the objects in their new quarters. Everything attracts them with about equal force. They have had no experience from which to form preferences. (*17 to 18 hours old.*) Accordingly all objects within reach must be examined—the large letters and figures of the newspaper, the cracks in the floor, the wood work of their yard. They follow moving objects occasionally. The walking mechanism is fairly co-ordinated and under control. They never topple over backwards, and rarely tumble while moving forward. Loud and sudden noises shock them—not quite fright, for they never try to escape. Banging on a tin pan, thrumming a guitar, tooting a horn, clapping the hands, causes them to start, squat and shudder.

2 P. M. No. 2, 22 hours old, catches and swallows a wingless fly. I drop an earth worm (*Lumbricus*) before them. No. 1 looks at its serpentine movements, steps back skittishly, and gives for the first time the well known danger churr, approaches the worm, pecks it, wipes his bill, pecks again and then lets it alone. I give them two more worms. No. 2 spies and approaches one, strikes it twice, wipes his bill, and lets them alone. Their bills are yet too weak to seize earth worms.

4 p. m., chicks one day old. I heard an unusual piping in my poultry yard. No. 2 had jumped out of the warm box—a feat five inches up and a fall fourteen inches—into the yard. He is now the sole occupant. When I approach he scurries behind the box and crowds close up in the corner of the yard. This is the first time that he seems afraid of me, or has shown signs of genuine fear. I drop earth worms in the yard a second time, both show signs of fright and do not even peck at them.

No. 3, born 11 A. M. Placed it on a newspaper at 3 P. M. Its efforts to stand, walk and swallow, closely parallel those of 1 and 2. It made three attempts to follow me, and one to overtake an old garment folded up and dragged slowly by it. I did not permit it to overtake the garment. Later drew it by several times, but it took no further notice of this garment. It sleeps when not molested.

No. 4 or "the lonely chick," born August 29, 3 P. M. This chick is completely isolated from all others of its kind for four days less eight hours. His food is confined to bits of half matured maize and occasionally cracked wheat and water. Of course he gains a knowledge of the food qualities through experience by pecking at the several objects of his prison, *e. g.*, specks in the carpet, nail heads, rollers of table, large letters in the newspaper, etc.

Second day. August 30, 7 A. M. No. 2, as before, has jumped out of his box and shows signs of fear at my approach,

but when I hold out my hand he runs to it and eagerly surveys it. Yesterday he avoided his excrement after four experiences pecking at it. This morning he shows evident signs of disgust at the first trial.

9 A. M. I place a tin of water on the floor. All three run up and peck the brighter portions of the vessel while walking around it. I trouble the water gently by rocking the vessel. No. 2 sees the ripples, stretches his neck to examine, at the same time stepping back and uttering the danger churr. This is not at the motion of the tin, for they have been accustomed to this all along. When the surface of the water quiets, No. 2 approaches and begins pecking at shiny places as before. In doing this he throws a bit of cracked wheat lying on his head into the water, he seizes and swallows it as usual and smacks his bill, as if tasting, then thrusts it into the water up to his eyes, turning his head up he drank after the characteristic chick fashion. This was an entirely new movement, for bill, head and neck. It was executed to perfection. He dips his bill in twice more and as deep as before. This seems unpleasant, for he walks away hurriedly each time and wipes and scratches his bill. A bit of spider web thoroughly filled with wood dust bored out by a bee fell into the yard. No. 2 pecked at it six times. It gives him no satisfaction. He let it alone. Nos. 1 and 3 then give their attention to it. They soon desert it.

10.30 A. M. Offer them water a second time. No. 1 discovers it for himself somewhat as No. 2, *i. e.*, by pecking at a speck on its surface. Both 1 and 2 now drink together. No. 3 steps up and watches the motions of No. 1 in a single act of drinking. He immediately begins to drink. No. 2 has learned to thrust his bill in at the ordinary depth. I offer them an earth worm for the third time, this time as food, in my hand. All come up and look in. No. 2, who leads in everything, sees it crawling, gives the danger note, at this the others look more intently, then all walk away. They fear more things with age. Sounds that yesterday were unheeded are to-day listened to with surprise and fear. They shy away short distances whenever I approach. My hand, to which they have become accustomed, brings them back. Evidently they have not become acquainted with my body as a whole.

4.30 P. M. I give them bits of yellow pine in one portion of their yard and cracked grains of yellow maize in another. The morsels of food look not unlike. They eat the maize as usual. No. 2 seizes a bit of pine, fumbles it in his mouth, drops it, tries another, drops it likewise, and pays no further attention to the wood. No. 3 tries three different pieces before swal-

lowing one. He swallowed two bits, then turned to the heap of maize.

5.30 P. M. I gave them bits of starched muslin cut about 1 mm. square from old collars and cuffs. All three attack the little pile eagerly. No. 1 swallowed a piece; No. 3 ran off with quite a large piece; the others gave chase. This heightened, apparently, the desire of each to secure it. They snatch it from each other's mouths until No. 3 despatches it. They return to the muslin, look at it, pick up pieces lightly and drop them. Their appetites for muslin soon quail. It was the last that I persuaded them to eat. Competition even at two days old spurs them on to more prodigious tasks. No. 2 has tried repeatedly to swallow a whole grain of maize, but without success. No. 1 attempts to snatch it away. The grain passes back and forth from mouth to mouth, while chasing each other around the yard, until finally No. 2, although hard pressed, makes an unusual effort to swallow it and succeeds.

4 P. M. No. 4, the chick in solitude now one day old, is offered a tin of water. Gives it no attention. Drop food near the sides of the vessel, and later a few bits in the water. It seizes the food on the water, thereby getting water in its mouth. The stimulus touches off the drinking apparatus, for it at once goes through the drinking movements. But the water seems to frighten it very much. It runs off some distance; wipes its bill repeatedly. I coax in vain for it to return to the tin of water.

Third day. August 31, 9.15 A. M. I give Nos. 1, 2 and 3 green cabbage worms for the second time. No. 2, as usual, gave danger churr, all walk away. They still fear earth worms. Nos. 1 and 3 contend over a bit of muslin, but soon neglect it. I threw them several bits of muslin—all came up and looked at it and then walked away. They treat pine wood similarly. Show joy when I sprinkle wheat and Indian meal on the floor by running up and flapping their wings. They devote more time to preening their feathers and stretching in the sun. I thrum the guitar as on first day. No. 2 scurries away behind the warm box, and 3 runs and squats as if hiding. I wave the guitar over the yard once. No. 1 runs screaming to the farthest corner and tucks his head under the edge of the paper that forms the wall to their yard. A wasp flies against the window, No. 2 gives the danger sign, the rest listen. A sailing cloud throws a rapidly moving shadow across their home, it frightens them very much.

10 A. M. No. 4, now nearly two days old, is again offered water. It looked in the vessel then walks away, did this three times.

September 1, 8 A. M. Nos. 1, 2 and 3 still avoid earth

worms, caterpillars and green canker worms. They learned to drink milk yesterday in much the same way as they did water. They show no sign to-day of having seen it before. They approach it cautiously, peck around the edges of the tin for six minutes, and after much stretching and craning of their necks in looking at the milk, begin to drink it. Their experience with the white boring grub is interesting. Nos. 1 and 2 are afraid of it, No. 3 seizes the grub while curled up, looking not unlike a grain of corn. No. 1 gives chase, and, as usual, the desire for the worm is increased until No. 3 swallows it. I give them three more grubs. The grubs begin crawling, and so long as this is kept up the chicks give the usual danger note and crane their necks forward in fear and wonder. The smallest of the grubs stops crawling, No. 3 seizes and swallows it at once. This, I judge, encouraged him to try the second largest. No. 2, by imitation, seized the largest grub, which I had considered too large for them to swallow. The others endeavored to share so large a morsel with No. 2. This precipitated quite a tussle, which ceased by the lucky one despatching the grub.

12 M. I take Nos. 1, 2 and 3 on an outing, as it were, of one hour and forty-five minutes, into a large grass plot. While here their behavior, more than ever, impresses me of the great importance that experience plays in their acquaintance with the chicken world. They were unusually active the entire time, pecking at the different grasses, seeds, sticks, dried leaves, bees, crawling ants. The bright husks of the pepper weed and the seeds of the short wire grass received their first attention because of their brightness. I concealed two black watermelon seeds under a tuft of grass, farther on a yellow seed, and in a third place the seeds of a cantaloupe. They discovered all three in due time—each discovery was attended with notes of surprise, and the investigation set out with cautious pecking. It seems that their nerves are keyed for responses to every stimuli of sight and sound, that their organism is essentially nervous, responding and adjusting to a novel environment. No. 3 spied an earth worm coming out of the ground. He seized it at once, and pulled and tugged at it not unlike robin red-breast in a similar feat. This was the first earth worm eaten. No. 4 (the lonely chick) is not thriving like his congeners. His body is becoming short and rounded, "dumpy;" the head is drawn in close to the body. When not eating he pipes the lonely want note. His efforts to make friends with a half-grown cat was an amusing performance. Its first advances were met by gentle soft taps from the kitten, for which attention it chirped the satisfied note, and made repeated attempts to cuddle up in the kitten's fur. This appeared to annoy her felineship. She began moving backwards on three

feet, using a fore foot to bar the chick's too familiar advances. Her pats finally grew to taps, then to slaps, and at last to a severe box that sent the chick rolling over several times. This experience destroyed the chick's desire for further affiliation with the cat. Nos. 1, 2 and 3 after eating a full meal spend much time in making their toilet, basking in the sunshine and engaging in mock fights. These and other activities essentially chick-like, are the fullest and most varied after a sumptuous meal.

Fourth day. September 2d. They still show signs of fear when I drop a small earth worm before them. But this time No. 3 seizes one before it begins crawling. This whets the appetites of the others. I divert the pursuer's attention by dropping another worm, it is seized and carried to one corner to be devoured. They now seize small *moving* worms, but large *crawling* ones overtax their courage. They are now indifferent toward green cabbage worms, do not even show signs of fear in their presence. White grubs are attacked and eaten, if not crawling; the crawling grub presents a sight too hideous for them, even at the age of four days.

No. 4—the lonely chick—now nearing the age of four days, is brought from his isolated quarters to my poultry yard. He presents a dumpy, ill-conditioned form and a fretful, timorous attitude, yet always ready to eat. The three approach and station themselves in a semi-circle about the stranger. Nos. 1 and 2 give the astonish or surprise chuckle. All three stretch their necks and peer scrutinizingly at the intruder as if "to look[1] him out" of their presence. No. 1 advances and strikes him a severe blow on the head. He attempts to return it, but is struck again and seized by the head and pulled and jerked about in battle royal fashion. At this treatment he screams the shrill cry of distress and tries to escape from the yard. He is nagged for some minutes, and finally permitted to stand in one corner and utter those lonely piteous cries that he has been making ever since he began to walk.

I now distribute several kinds of food in distant parts of their yard, thereby increasing the unwelcome stranger's opportunities for getting his breakfast. He makes good use of the advantage, and snatches a morsel now here, now there. Although he is occasionally struck at, it is apparent that his presence is becoming more tolerable, and in time will be suffered to remain in peace. And so he was at the expiration of two hours with all four basking together in a parallelogram of sunshine. They lie on one side, stretch the free leg and

[1] The reader will understand this phrase as merely descriptive of their appearance and nothing more.

wing at full length. So well at ease had No. 4 become that while thus stretched out on the floor, he raised the free expanded wing and fanned it gently back and forth showing every sign of comfort. This is the first time he has shown genuine contentment. It took companionship to make his life complete. I gave them grubs and earth worms, which were eagerly devoured, after which I offered them green cabbage worms. This was No. 4's first experience with worms of any sort. He had just witnessed the others eat grubs and earth worms with impunity. So when the green cabbage worms appeared, he did not hesitate to devour them while the others stood back or walked away. But his spirited and ravenous dealing with the worms induced the others to rob him of a worm—a lively chase ensues which ends in the competitors devouring fragments of the worm.

The only activity during their outing to-day (ages four and five days) that deserves notice is that of wallowing on the hard ground and shuffling the wings after the manner of full feathered birds when taking a sand bath. The motion of the wing, when sand is present, both gathers and throws the sand over the entire body not unlike a shower bath. The movement appears complex.

Fifth day. September 3, 7 A. M. Cabbage worms are offered No. 4 the second time. Nos. 1, 2 and 3 stand aloof. No. 4 eats one, wipes his bill vigorously several times, returns to the squirming heap, shakes his head. He never ate cabbage worms after that. My chicks have a peculiar way of shaking or slinging the head—as if in disgust, at the sight of an object disagreeable to their taste. Again during their outing they indulge in attempts to wallow on the hard ground. They made a similar attempt on the floor. They now appear to know their "outing grounds." So soon as placed on the ground they run and dart hither and thither and flap their wings, and engage in mock fights.[1] This usually begins by a sudden and simultaneous darting about and clapping the wings, and then rushing together giving each other light pecks. They are less timid, pay less attention to the various noises and sights about them, and wander farther away from me and from each other. When these little excursions isolate them the lost note is piped. They always find their way back. To-day for the first time they give evidence of wishing to perch in high places. No. 1, after walking around a basket, five inches high, several times and looking at its top, mounts to its rim, and as soon as he has balanced himself sits down. Later at roosting time he tries to

[1] See Wundt, pp. 357-8, and Karl Groos: The Play of Animals. D. Appleton Co., N. Y., 1898.

fly to a horizontal stick four inches high, forming a part of the yard's frame-work. He also flies up the side of the paper wall and pipes the distress note when he wants to go to roost. He invariably chooses the same corner of the wall over which he attempts to make his escape, and although he mounts only a very small fraction of the wall, his efforts never tire in covering that small distance. I offer them again bits of muslin and pine wood, which they have not seen for three days. The muslin is ignored, several pieces of pine are picked up and dropped by each one. No. 2 finally swallows a piece—the fifth that he had examined. He walks away and wipes his bill. Four days later I offer them pine wood. It received no attention this time even though I continued to sprinkle it before them as I do grain.

Sixth day. September 4th. After eating their breakfast, wallowing in fresh, loose ground and preening feathers, Nos. 2 and 4 engage in a mock fight. No. 4 sits on the bottom rung of a ladder, the top of which rests on the top of the yard enclosure, thus affording an outlet, should they make an effort to use it. This occurred at 8 A. M. At 8.45 No. 3 walks halfway up the ladder and sits down. No. 4 attempts to fly up to No. 3, but fails. No. 3 gets up and continues his way up the ladder; at a height of 18 inches he stops, looks about, both feet and wings tremble and quiver. Steadying himself, he turns around and descends the ladder to a height of 10 inches, sits down and completes his toilet in apparent ease. They now seize earthworms whether moving or crawling.

An instinctive movement was made by No. 2 at the close of his toilet exercise, that is both comical and instructive. After smoothing out the pin feathers of his breast and straightening out the sprouting remiges, he stretched up at full height, flapped his wings against his sides in approved gallinaceous style, and at the close of the wing movements swished and wiggled the little bunch of cottony pin feathers that occupy the place of the future tail feathers—a beautiful illustration of complete development and co-ordination of both nervous and muscular apparatus long before there is any need of their functioning; for the tail feathers over which these nerves and muscles have control did not show themselves until three weeks later.

Seventh day. September 5th. I notice that they are quite sensitive to changes of temperature. No. 1 stepped on a motionless earth worm. The foot was taken off with a sudden jerk. It had not noticed the worm. I laid a cold copper wire down, one stepped on it and immediately jerked the foot up. Their room has a southeast exposure. The first rays of the sun fall on the right wall of their yard about one foot from the floor. They spend much time in looking at the bright spot.

It descends obliquely to the floor, reaching it in about twenty minutes. They have now learned to stand ready waiting for the warm rays to fall on them. These September mornings are chilly. The direct sunlight reaches the left side of the yard by noon. They follow it up as it crosses the yard whenever they make their toilet or wish to cat-nap.

8.30 A. M. No. 3 mounts the ladder and climbs the rungs quite a distance, sits down at a height of 11 inches. Nos. 2 and 4 stand under him, stretching and peering their heads up, and try to fly up. It did not occur to them to walk to the lower end of the ladder and walk up. This is the third time that No. 3 has perched on the ladder, and every time 2 and 4 have tried to reach him by flight, standing directly under, notwithstanding too, that both have seen No. 3 begin his ascent at the end of the ladder.

5 P. M. No. 4 for the first time walks to the top of the ladder. This gave him a view of the world outside the poultry yard. He looked intently in several directions and at times uttered notes of surprise and the "wonder chuckle." He walked a short distance from the end of the ladder out on the top of the wall of the yard. He looked first on the outside, then on the inside, as if in doubt which way to fly. He finally flew down in his old yard. No. 1 for the past three days grows very restless at the approach of night and tries to escape as before described. He walks around the four sides of the yard; on reaching the fourth corner he attempts to fly oyer. He is as persistent in his efforts as a bee against a window pane. He has ample opportunities for learning to use the ladder, but pays no attention to it when he wishes to escape. All have taken a turn in walking up the ladder, save No. 2, who is very large for his age, with wings undeveloped. He never shows discontent. His fellows have small bodies but rapidly growing wings. They grow restless. No. 4 has made two more excursions to the top of the ladder. An outside ladder butts against the inside one at the top of the yard wall. No. 4 stepped on this ladder, walked down two rungs, uttered a cry of fear, stepped off backwards on to the inside one and walked down into the yard.

Eighth day. September 6th, 6.45 A. M. Gave them green canker (cabbage) worms. They gave the surprise chuckle, finally No. 4 seized one, then all gave chase until he swallowed it. All return to the worms, but refuse to take hold. They begin to clamor for food.

7.30 A. M. They have had a sumptuous breakfast. Preening feathers, mock fights and the like follow. No. 4 has walked to the top of the ladder four times since breakfast. He has stepped on the outside ladder twice. The others still watch

him as if they too would like to climb up. During the forenoon he climbed the ladder fourteen times. Sometimes he would step on to the outside ladder but never ventured to walk down. After his noon meal he walked up the ladder and out on the top of the poultry yard fence. He walked back and forth leisurely on the wall and while attempting to catch a passing fly he slipped off and dropped on the outside. He showed signs at once of desiring to return to the yard. He walked around and under the outside ladder. It was made exactly like the inside ladder and leaned against the wall at the same angle, but it never occurred to him to use it. During the space of an hour he walked back and forth along the wall thirty-two times, and put his head through a small crack, looking into the yard, thirty-eight times. Toward the end of the hour he became more reconciled to his lot and began to search for food.

Ninth day. For some time they have been pulling off bits of paper forming the wall to their yard to get the flour paste used in their wall paper. To-day they pecked and pulled at a piece that turned in until they made an opening large enough through which to escape. They walked out. I put them back. They went at once to work and pulled it in and up. Out they went again. This was repeated until I fixed it securely. I kept them in their poultry yard until the age of fourteen days. They never learned to use the two ladders as a means of egress and ingress, although I frequently put them through the movements of climbing one ladder and descending the other.[1]

Conclusions.

1. Both hearing and sight are dull during the greater part of the first day. They develop very rapidly the second and third day, being highly sensitive on the third to any and all sounds and noises.

2. Pecking is better developed from the first than swallowing, in fact the muscles for holding the head erect, for controlling the jaws, and the process of deglutition are very weak the first 8 or 10 hours.

3. Fear increases with the development of sight and sound.

4. The instinct to follow soon fades out. Hovering and cuddling together are instinctive. Both Morgan and Mills seem to think that hovering under the hand or following it is due to the warmth it affords them. I find they follow any small moving object at first. Later the hand becomes a very interesting object; their attachment grows out of its being their only source of food.

[1] To expect them to learn a task by forcing them through it, has impressed me since as a very artificial if not an actually absurd thing to do.

5. Mock fights begin the third day, and shade over into serious business the sixth week.

Wundt[1] regards mock fighting as the only type of play among animals, and interprets it along with Karl Groos[2] as a schooling to the serious struggles of adult life.

The different degrees of permanency of their associations suggest a problem for extended work among several species. They rejected pine wood after a few experiences at the age of three days, but three days later they ate it again, while experiences with muslin on the third day was lasting. They were six days getting acquainted with earth worms, and eight days with the canker worms.

They learn to do some things by imitation, *e. g.*, drinking, learning to eat certain foods, escaping from their enclosure, while other tasks of apparent equal simplicity are not learned. Though the fortunate one performs the trick before them every day. No. 2 learned to escape from the "warm box" at one day old, the others, more agile in most things, never learned the trick. I quit putting them into the box the fifth day. Dr. Thorndike[3] inclines strongly to the belief that domestic animals do not imitate each others performances. This belief is founded on the results from experiments conducted exclusively on what I have called the *experimental method.* Describing his method he says: "It was merely to put animals when *hungry* in *enclosures* from which they could escape by some simple act, such as pulling at a loop of cord, pressing a lever, or stepping on a platform." The motives, then, played upon were hunger, desire for freedom, and surely in many cases fear—especially would this likely to be true with the young brought into novel situations. Imitative activities form a good part of play activities—not all play is imitation, nor *vice versa*, but much of the two are on common grounds, and find their fullest expression under similar conditions. What are these conditions? Just the opposite to those created in his experiments, viz., freedom, security from harm, satiety, in a word—well being. Nothing so shrinks and inhibits completely the fullness and variety of an organism's activities[4] than prison[5] life[6] and fear.[7] Dr. Thorndike first teaches a chick to escape from a certain situation, then places along side of this one that "knows the ropes"

[1] Wundt: Human and Animal Psychology, p. 358.
[2] Groos, Karl: The Play of Animals. Translated edition, 1898.
[3] Thorndike, Edward L.: *Loc. cit.*, p. 6.
[4] Verworn, M.: Pflüg. Archiv., Vol. L, 1891, pp. 439-440.
[5] Cornish, C. J.: Animals at Work and Play, pp. 31-38, 1896.
[6] Jordan: Habits and Developments of Newts. Jour. Morphology, Vol. VIII, pp. 269-366.
[7] Kline, L. W.: *Am. Jour. Psy.*, Vol. X, No. 1, 1898.

others entirely ignorant, and says by his experiment "imitation if present will surely come forth." To get a particular tone from a musical instrument we must play on certain definite keys. Dr. Thorndike has played the wrong keys. It seems to me all that we can say at present is that some individuals of a species learn some things by imitation. I heartily agree with Professor Mills who finds wide individual aptitudes among members of the same brood, or family.

WHITE RAT.

The object of the experiment with the white rat was to ascertain its susceptibility to profit by experience, to test its quickness to learn by appealing to its most dominant and characteristic activity in food getting, the readiness with which contiguous associations are built up.

For this purpose stimuli was addressed to the rats' pawing and digging[1] activity by means of the following device: (1) A box 8 inches long, 7 inches wide, 6 inches deep, whose sides were of wire, top of glass and bottom of wood, was put into their home box, which also served for an observation box. At one end of the floor of the small box a piece 3½ inches long and 2 inches wide was sawed out. The box was raised above the level of the floor by resting on two strips 1½ inches thick; (2) sand and sawdust was heaped up loosely around the sides of the box until it rose a little above the level of its floor; (3) food (dog biscuit and cheese) was put in the box.

The observation box, containing two rats, was 18 inches long, 14 inches wide and 14 inches deep, one side was wire, one end glass, the rest of wood. The rats knew practically no other home, they had been reared in much the same sort of box. Before beginning the experiment I left the experiment box in their home several days, so that they had become quite familiar with it. Their exceeding timidity makes such precautions necessary.

Experiment I. January 9th, 2 P. M. Both rats at once attacked the box, crawled up the sides, over the top, and went round and round in a very monotonous fashion—always smelling. They persevered nearly an hour. At 3 P. M. their movements were less decided, seemed more haphazard and indifferent. One gave up and returned to the nest,—the second, somewhat more frisky, began scratching the sawdust in that very instinctive fashion which I have observed them do under

[1] I am not yet satisfied that I have appealed to its dominant trait or method of food getting. On *a priori* grounds I had thought that the gnawing activity was the best developed—a tentative experiment threw doubt on this and suggested the one used.

all sorts of conditions, even when they are well fed. It appears to be a "wild trait in a tame animal," as Robinson[1] has characterized such more or less useless instinctive performances among our domestic animals.

The hole thus accidentally dug happened to be at the end of the box where the piece had been taken out of the floor. The rat immediately poked its nose into the new opening which was not large enough to admit its head. It seemed to be frightened, ran to its hiding place, came out after about a minute, smelled cautiously about the hole, and dug away more material, then scampered away as before. These acts were repeated several times, until an opening quite too large had been made. It then ventured cautiously up into the box, snatched the food and carried it to its hiding place at 3.30 P. M., after working one hour and thirty minutes.

Experiment II. January 10th, 3.45 P. M. They behaved to-day much like the preceding, *i. e.*, climbing up the sides, walking over the top, except that they spent more time about the place where they had excavated the day before—seemed to have located the place in an indefinite sort of fashion. They frisked and fidgeted about 4 minutes, then one began digging with a will, and did not stop this time until the work was complete. But, as before, they hesitated to enter at once into the hole and box, they frisked nervously about for some time—coming up, peeping into the hole, then scampering off. At 3.53 P. M., or after eight minutes' work, one ventured in after the food.

Experiment III. January 11th. Set experiment agoing at 2.12 P. M. One came out of nest about a half-minute before the second. They did not climb up the sides and over the top of the box, but confined their movements about the place where they had made the burrow the two preceding days. After smelling around 1½ minutes, No. 1 went to work and in a half minute a hole of sufficient size was made. This time there was no hesitation; it went right in. Snatched the food at 2.14 P. M. Time in getting food 2½ minutes.

Experiment IV. January 12th. Experiment began 4.17 P. M. Rats came out immediately, climbed up side of box, then on to top, walked about sniffing the air, crawled down, and went at once to the usual digging place. At 4.20 it took food out. Time, 3 minutes.

Experiment V. January 13th, 4.15 P. M. Rat No. 1, only, came out. Approached the box leisurely, sniffed the air quite often. Stood erect, with forepaws against the box. Suddenly,

[1] Robinson, Lewis: Wild Traits in Tame Animals, 326 pages. Edinburgh and London, 1898.

as though the idea had just possessed it, it got down and began the usual excavation. Stopped when half done, walked away, came back, finished the opening, and took food at 4.18½ P. M. Time, 3½ minutes. The indifference manifested in this experiment I think is due to their being too well fed. No. 2 did not even leave his nest until No. 1 had started home with his food. It is evident that they have learned how to get their food (during the experiment it was given in no other way), and that they must have greatly profited by their *first* experience—the first attempt to reach the food required 1 hr., 30 min.; the second attempt, 24 hours later, only 8 minutes. I am not persuaded, however, that the elements in the associative chain, whatever the psychologist may decide their nature and number to be, have as yet taken on any very stable and clear form. They seldom begin digging at the proper place, sometimes will begin holes in several different places, and they will not dig at all until they have made several examinations of the box. All these preliminary activities may fade out in time.[1]

The methods presented here enable us in a comparatively short time to point out more distinctly, and that, too, in an elementary way, the dividing lines between instinct,[2] intelligence, and habit, *e. g.*, it was instinct that prompted my chicks to perch, or my rats to scratch up the sawdust; it was intelligence gained through chance experience, that enabled the chicks to escape from the yard, and the rats to get food from the box; it was habit that made the chicks go in a particular roosting box, unsolicited, at the approach of night, while they were wholly indifferent to another box and would escape from it if put in it.

To Dr. Edmund C. Sanford I desire to express my best thanks, not only for suggesting the work itself, but for valuable help and timely suggestions at every turn during its execution.

[1] I have since performed 8 more experiments. The time has been reduced to 30 seconds, and many of the useless preliminary performances have been dropped.

[2] Morgan C. Lloyd: Habit and Instinct.